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Indian Standard

METHOD OF TEST FOR NON-COMBUSTIBILITY
OF BUILDING MATERIALS

(*First Revision*)

UDC 691 : 536.468



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INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Indian Standard

METHOD OF TEST FOR NON-COMBUSTIBILITY OF BUILDING MATERIALS

(*First Revision*)

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(Continued on page 2)

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IS : 3808 - 1979

(Continued from page 1)

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Indian Standard
**METHOD OF TEST FOR NON-COMBUSTIBILITY
OF BUILDING MATERIALS**
(First Revision)

0. FOREWORD

0.1 This Indian Standard (First Revision) was adopted by the Indian Standards Institution on 10 April 1979, after the draft finalized by the Fire Safety Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 It may be important to ascertain whether a material will or will not contribute directly to fire development and this method of test has been designed to allow this to be done. The results obtained from this test will provide information from which regulating authorities will be assisted in deciding whether the material in question may be used without undue hazard in certain locations in buildings.

0.3 This standard was first published in 1966. The present revision has been based on ISO 1182:1979 Fire tests — Building materials — Non-combustibility test. The term 'combustibility' has been replaced by 'non-combustibility' as this defines the scope of the test in a better manner and is in line with the designation adopted by ISO.

0.4 In reporting the results of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2-1960*.

1. SCOPE

1.1 This standard lays down the method of test for determining one aspect of reaction to fire, that is non-combustibility of a material with a view to evaluating the tendency of the material to release more than a certain amount of heat or to flame in the circumstances of the test.

*Rules for rounding off numerical values (revised).

1.2 This test is intended for building materials or products, whether coated or uncoated but it is not intended to apply to the coating alone.

NOTE — So that suitable precautions are taken to safeguard health, the attention of all persons concerned in fire tests is drawn to the possibility that toxic or harmful gases may be evolved in combustion of test specimens.

2. APPARATUS

2.1 General Description

2.1.1 The apparatus of which an illustration is shown in Fig. 1, shall essentially comprise:

- a) a refractory tube (the tube), surrounded by heating coils and insulation (this whole assembly is the 'furnace');
- b) an air flow stabilizer, at the base of the tube;
- c) a draught shield, at the open top of the tube;
- d) a specimen holder (see Fig. 2) equipped with a suitable insertion device for lowering and raising it on the axis of the tube;
- e) three thermocouples (see Fig. 3)
 - 1) furnace thermocouple,
 - 2) specimen centre thermocouple (centre thermocouple), and
 - 3) specimen surface thermocouple (surface thermocouple);
- f) a temperature recorder;
- g) a stand for the furnace; and
- h) air flow shields.

2.1.2 In addition, one of the following means shall normally be provided for checking the temperature of the inner wall of the tube to assist calibration:

- a) A sheathed thermocouple scanning device; or
- b) An optical micropyrometer.

2.2 Furnace, Stand and Air Flow Shields

2.2.1 The tube shall be made of alumina refractory material (density $2\,700 \pm 500 \text{ kg/m}^3$) and shall be $150 \pm 1 \text{ mm}$ high with an inner diameter of $75 \pm 1 \text{ mm}$ and a wall thickness of $10 \pm 1 \text{ mm}$. The overall wall thickness, with applied refractory cement to retain the electrical winding, shall not exceed 15 mm.

2.2.2 The tube shall be provided with one or more electrical heating coils so that the temperature of the tube can be raised to the requirements specified in 3.2.

2.2.3 The tube shall be well insulated within an insulated surround consisting of magnesium oxide powder of bulk density $140 \text{ kg/m}^3 \pm 15\%$ contained by a cover made of asbestos cement or similar material and completed with a top and bottom plate of insulating board having a thickness of $10 \pm 1 \text{ mm}$.

2.2.4 The furnace shall be provided with a firm stand to ensure that the bottom of the furnace is held steady at least 750 mm above floor level. The stand shall be made of steel or other suitable material adequate to provide a firm base for the furnace and air flow stabilizer.

2.2.5 When tests are in progress air flow shields, shall be fixed to the stand to enclose the space below the air flow stabilizer up to a height of approximately 550 mm above the floor (see Fig. 1).

2.3 Air Flow Stabilizer

2.3.1 At the base of the tube, an open-ended conical air flow stabilizer, as shown in Fig. 1 shall be attached. The joint between the air flow stabilizer and the tube shall be smooth and airtight under all conditions and shall be provided with a seal. The stabilizer shall have a smooth inside face and its upper half shall be insulated on the external face. Below the stabilizer there shall be a gap of approximately 250 mm which shall be protected against disturbance by air currents.

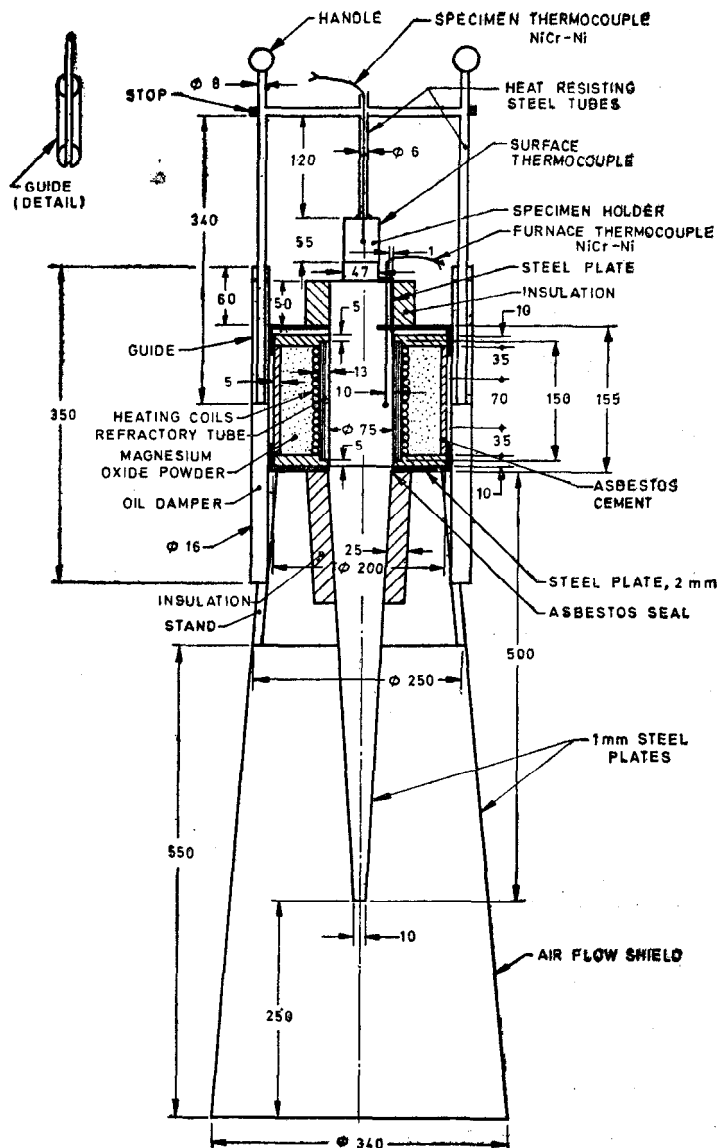
2.3.2 The stabilizer shall be 500 mm long. Its internal diameter at the top shall be 75 mm and shall reduce uniformly to an internal diameter at the bottom of 10 mm.

2.3.3 The stabilizer shall be made of sheet steel approximately 1 mm thick and finished smooth on the inside. Its upper half shall be insulated on the outside with a layer of fibrous or other suitable insulating material $25 \pm 2 \text{ mm}$ thick and of density between 40 and 120 kg/m^3 .

2.4 Draught Shield

2.4.1 At the open top of the tube a draught shield shall be provided. It shall have a smooth and airtight joint with the tube and shall be insulated on the external face.

2.4.2 The draught shield shall be made of the same material as the air flow stabilizer (see 2.3.3) and shall have an internal diameter of 75 mm and a height of 50 mm. It shall be insulated on the outside with a layer of fibrous or other suitable insulating material $25 \pm 2 \text{ mm}$ thick.

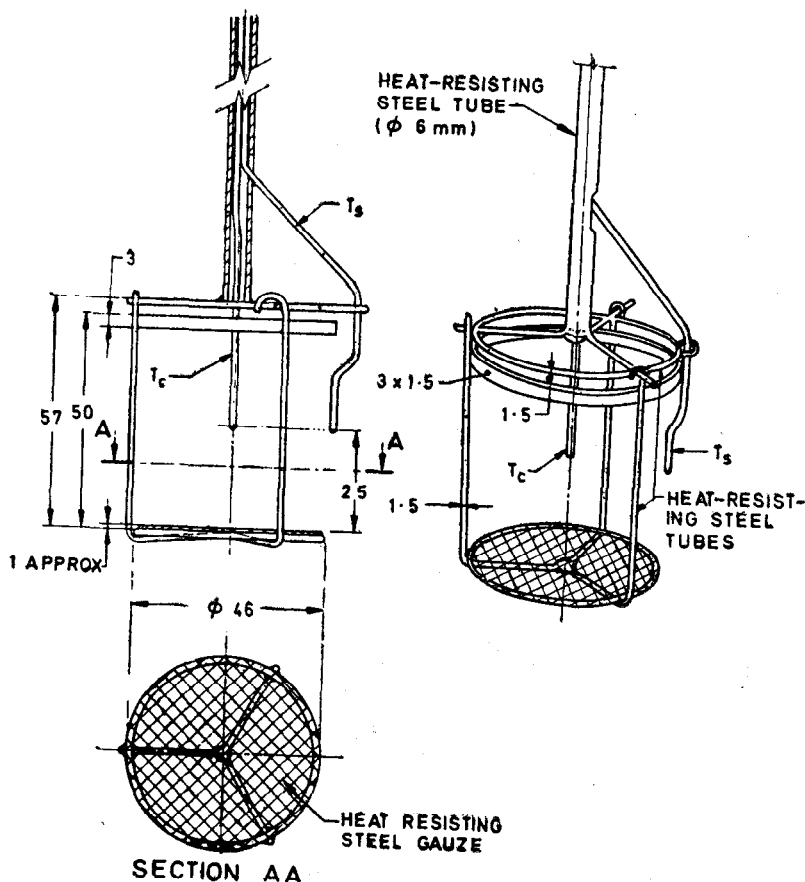


All dimensions in millimetres.

FIG. 1 NON-COMBUSTIBILITY TEST APPARATUS
(GENERAL ARRANGEMENT)

2.5 Specimen Holder and Insertion Device

2.5.1 The specimen holder (*see* Fig. 2) shall be provided with a suitable insertion device for lowering it precisely down the axis of the tube and for rapidly raising it again on the same axis without shock. They shall be made in such a way as to ensure that the specimen when in position for the test occupies a position in the middle of the controlled temperature zone of the furnace (*see* 3.3) and is equidistant from the walls of the tube.



All dimensions in millimetres.

FIG. 2 EXAMPLE OF A SPECIMEN HOLDER

2.5.2 The specimen holder, which is basically cylindrical, shall conform to the dimensions given in Fig. 1 and 2, and shall have a mass between 15 and 20 g. It shall be capable of holding a specimen which conforms to 4.2.

2.5.3 The holder and the insertion device shall be designed in such a way as to permit the attachment of the two specimen thermocouples (*see* 2.6.2, 2.6.3 and Fig. 2).

2.5.4 The frame of the holder shall be made of rods of nickel-chromium alloy or of heat-resisting steel and shall be suspended from the lower end of a tube of heat-resisting steel having an outside diameter of approximately 6 mm and a bore of 4 mm. The bottom of the holder shall be formed using a fine gauze of heat resisting steel. It shall be so made that the lower part can be unhooked from the uppermost ring to permit insertion of the specimen.

2.5.5 The insertion device shall be a metallic sliding rod moving freely within vertical guides fitted to the sides of the furnace (*see* Fig. 1). The heat-resisting steel tube, from which the specimen holder is suspended (2.5.4), shall be fixed by a space bar to the sliding rod.

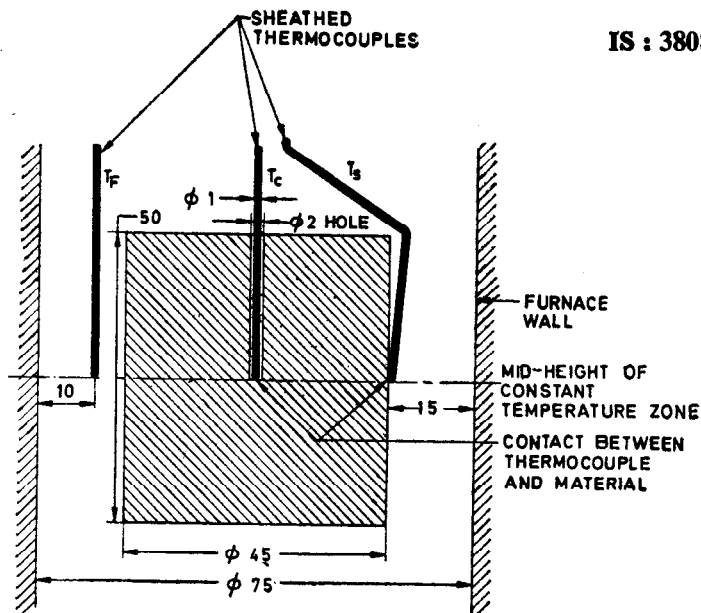
2.6 Thermocouples

2.6.1 The furnace thermocouple shall be located with its hot junction 10 ± 0.5 mm from the tube wall and at mid-height of the controlled temperature zone (*see* 3.3) as defined by the wall temperature. The correct distance from the wall shall be maintained by use of a guide attached to the draught shield.

2.6.2 The surface thermocouple shall have its hot junction in contact with the specimen at mid-height of the specimen at the start of the test and shall be located diametrically opposite the furnace thermocouple (*see* Fig. 3).

2.6.3 The centre thermocouple shall normally be used and, if so, shall be attached to the specimen holder in such a way that it moves up and down with the holder and is located with its hot junction in the centre of the specimen. It shall be inserted from the top through a hole of 2 mm diameter (*see* Fig. 3) so that the hot junction makes contact with the bottom of the hole. In some cases, however, the centre thermocouple provides no significant additional information and in such cases it need not be used.

2.6.4 All thermocouples, during a test, shall have their hot junctions located in the same horizontal plane, which shall correspond to the mid-height of the controlled temperature zone.



T_F = Furnace thermocouple
 T_c = Specimen centre thermocouple
 T_s = Specimen surface thermocouple
 All dimensions in millimetres.

FIG. 3 RELATIVE POSITION OF FURNACE,
SPECIMEN AND THERMOCOUPLES

2.6.5 Each thermocouple shall be of stainless steel sheathed type having a mineral insulated junction and having an outside diameter of not less than 1 mm and not more than 1.5 mm.

2.7 Temperature Recorder and Temperature Measurement

2.7.1 The temperatures of the furnace and surface thermocouples shall be recorded by a continuous recorder having a measuring range that corresponds to the temperature changes that occur during the tests. For the centre thermocouple regular reading shall be recorded at intervals not greater than 5 seconds.

2.7.2 The temperature measuring equipment shall have an accuracy of at least 0.5%.

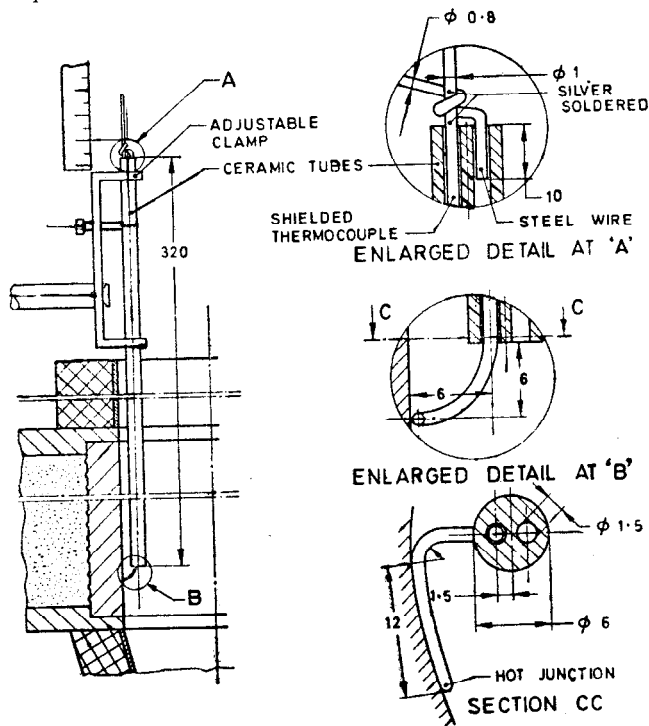
3. CALIBRATION AND CONTROL

3.1 A calibration test shall be performed on a new apparatus or any existing apparatus when so required. The aim is to ensure the required

degree of uniformity of the furnace wall temperature during tests and to establish the necessary power input. This test shall be performed with the specimen holder removed from the furnace.

3.2 Under stabilized furnace operating conditions, measurements of wall temperatures shall be made by use of either an optical micropyrometer or a sheathed thermocouple scanning device (*see* Fig. 4). Such measurements shall be made on three equally spaced vertical axes. The wall temperature when measured by sheathed thermocouple scanning device shall be within the range 800 to 850°C and have an average value of $825 \pm 5^\circ\text{C}$ (*see* Note). If, however, this wall temperature is measured by an optical micropyrometer it shall be within the range 815 to 865°C and have an average value of $840 \pm 5^\circ\text{C}$. When this requirement is fulfilled, the power input shall be measured and noted as the calibration power input.

NOTE — This average value corresponds to approximately 750°C at the furnace thermocouple.



All dimensions in millimetres.

FIG. 4 SHEATHED THERMOCOUPLE SCANNING DEVICE

3.3 A controlled temperature zone is achieved either by having closer winding at the two ends of the heated tube or by means of separate windings at the ends controlled independently of the central section. To minimize temperature fluctuations in the furnace it is necessary to use a voltage stabilizer. Between calibrations, the power input is maintained within $\pm 1\%$ of the calibrating power input for each test. Between tests, the temperature as measured by the furnace thermocouple shall be used to ensure that the furnace wall temperature returns to its steady state temperature before the next test.

NOTE — To assist control during the test it is necessary to prevent excessive variations in ambient conditions in the vicinity of the apparatus.

3.4 Automatic thermostatic control of the furnace is not to be used during test.

4. TEST SPECIMENS

4.1 Preparation — The specimens shall be as representative as possible of the average properties of the sample and shall be prepared to the size defined in **4.2**.

If the thickness of the material is less than 50 mm, the specimen shall be made of sufficient layers to achieve the thickness required in **4.2**. The layers shall be disposed horizontally and shall be held together firmly by means of fine wire to minimize air gaps between layers. The density of the specimens shall be representative of the density of the material.

For composite materials of a thickness such that a number of layers cannot be put together to give a specimen of the specified size as required in **4.2**, the specimen shall be prepared to the required thickness by adjusting the thickness of the different components. The top and bottom faces of the specimen shall be the finished faces of the material.

4.2 Number and Size — For test purposes five cylindrical specimens shall be prepared as described in **4.1**. The nominal dimensions and tolerances for the specimen sizes shall be as follows:

Diameter : $45 \pm_2^0$ mm

Height : 50 ± 3 mm

Volume : 80 ± 5 cm³

4.3 Conditioning — The specimens shall be conditioned in a ventilated oven maintained at $60 \pm 5^\circ\text{C}$ for at least 20 h and cooled to ambient temperature in a desiccator containing a suitable drying agent prior to

the tests. The mass of each specimen shall be determined prior to test in the furnace.

5. TEST PROCEDURE

5.1 Apparatus

5.1.1 Before starting the test, it is necessary to ascertain that the whole equipment is in good working order, for example that the stabilizer is clean, the insertion device is working smoothly and the specimen holder exactly occupies the required position in the furnace.

5.1.2 The equipment shall be protected against draughts and shall not be exposed to direct sunlight or external sources of heat.

5.1.3 The furnace shall be heated and the furnace temperature stabilized at the mean temperature established by the calibration test, so that it does not fluctuate by more than $\pm 10^{\circ}\text{C}$, for a minimum period of 10 minutes before the insertion of a specimen.

5.2 Insertion of Specimens — The specimen shall be placed in the holder described in 2.5 and inserted in the furnace taking not more than 5 seconds for this operation.

5.3 Duration of Heating — The heating period commences with the insertion of the specimen in the furnace and shall be continued for 20 minutes.

5.4 Test Observations

5.4.1 A record shall be made of the temperature readings from the thermocouples during the heating period and note taken of the occurrence and maximum duration of any sustained flaming. Sustained flaming shall be taken as the continuous presence of flames in the furnace lasting for 5 seconds or longer. The mass loss of each specimen shall be established after each test.

5.4.2 After cooling to ambient temperature, each specimen shall be weighed and the mass recorded. Where char, ash or other debris breaks off and falls down the tube during or following the test, this shall be recovered and included as part of the unconsumed specimen mass. The physical form or nature of any unconsumed non-recoverable decomposition products shall be noted.

5.4.3 Any other observations relating to the behaviour of the specimen shall be recorded.

6. EXPRESSION OF TEST RESULTS

6.1 The following results shall be noted and reported. Guidance on criteria for evaluation of performance from these results is given in Appendix A.

6.1.1 For each test the following temperatures shall be noted:

- a) the initial furnace temperature (T_o);
- b) the maximum furnace thermocouple temperature (T_F);
- c) the maximum surface thermocouple temperature (T_s);
- d) the maximum centre thermocouple temperature (T_c); and
- e) the duration of sustained flaming.

6.1.2 For each series of five tests the average temperature rise (*see 6.2*) of the following shall be reported:

- a) furnace thermocouple;
- b) surface thermocouple; and
- c) centre thermocouple.

6.2 The average temperature rise of furnace thermocouple [*see 6.1.2 (a)*] shall be calculated from the formula:

$$\sum_{i=1}^5 \frac{T_{Fi} - T_o}{5}$$

and similarly using T_s for **6.1.2 (b)** and using T_c for **6.1.2 (c)**.

6.3 For each series of five tests in which sustained flaming (as defined in **5.4.1**) is recorded, the average recorded duration of sustained flaming shall be reported. This is arrived at by taking the sum of all the recorded durations of flaming and dividing by 5.

6.4 The following mass loss shall be reported:

- a) the mass loss of each individual specimen in each test; and
- b) the average mass loss of the five specimens in each series of five tests.

7. TEST REPORT

7.1 The test report shall include the following information:

- a) name of the manufacturer or of the supplier of the material;
- b) name or identification of the product;

- c) description of the material;
- d) density of the material;
- e) date of supply of the materials and date of the tests;
- f) description of the specimens;
- g) test method ;
- h) test results as required by 6; and
- j) name of the testing laboratory.

APPENDIX A

(Clause 6.1)

CRITERIA FOR EVALUATION

A-0. In order to be able to assess materials in relation to 'combustibility' or 'non-combustibility', regulating authorities will need to define appropriate criteria for acceptance. It is desirable that in general when materials are assessed by a test, every assessment should be based on the same criteria unless very special factors exist in a particular case. It is, therefore, suggested that in all save the most exceptional circumstances no criteria other than the following should be used; it may not, however, be necessary or possible to use all criteria in every case (*see 2.6.3*).

A-1. The average of all five maximum readings of the furnace thermocouple shall not exceed the initial furnace temperature by more than 50°C.

A-2. The average of all five maximum readings of the surface thermocouple shall not exceed the initial furnace temperature by more than 50°C.

A-3. The calculated average duration of recorded sustained flaming shall not exceed 20 s.

A-4. The average of all five maximum readings of the centre thermocouple shall not exceed the initial furnace temperature by more than 50°C (*see 2.6.3*).

A-5. The average mass loss shall not exceed 50% of the average original mass.

It is the responsibility of the regulating authority to decide which aspects of the test are appropriate to particular usages.

INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

QUANTITY	UNIT	SYMBOL
Length	metre	m
Mass	kilogram	kg
Time	second	
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

QUANTITY	UNIT	SYMBOL
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

QUANTITY	UNIT	SYMBOL	DEFINITION
Force	newton	N	1 N = 1 kg.m/s ²
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m ²
Frequency	hertz	Hz	1 Hz = 1 c/s (s ⁻¹)
Electric conductance	siemens	S	1 S = 1 A/V
Electromotive force	volt	V	1 V = 1 W/A
Pressure, stress	pascal	Pa	1 Pa = 1 N/m ²

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